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Forthcoming Papers

Special Issue on the International Conference on MultiAgent Systems (edited by Ed Durfee, Sarit Kraus, Hideyuki Nakashima, Milind Tambe)

H. Bojinov, A. Casal and T. Hogg, Multiagent control of self-reconfigurable robots

We demonstrate how multiagent systems provide useful control techniques for modular self-reconfigurable (metamorphic) robots. Such robots consist of many modules that can move relative to each other, thereby changing the overall shape of the robot to suit different tasks. Multiagent control is particularly well-suited for tasks involving uncertain and changing environments. We illustrate this approach through simulation experiments of Proteo, a metamorphic robot system currently under development.

H. Tonino, A. Bos, M. de Weerdt and C. Witteveen, Plan coordination by revision in collective agent based systems

In order to model plan coordination behavior of agents we develop a simple framework for representing plans, resources and goals of agents. Plans are represented as directed acyclic graphs of skills and resources that, given adequate initial resources, can realize special resources, called goals. Given the storage costs of resources, application costs of skills, and values of goals, it is possible to reason about the profits of a plan for an agent. We then model two forms of plan coordination behavior between two agents, viz. *fusion*, aiming at the maximization of the total yield of the agents involved, and *collaboration*, which aims at the maximization of the individual yield of each agent. We argue how both forms of cooperation can be seen as iterative plan revision processes. We also present efficient polynomial algorithms for agent plan fusion and collaboration that are based on this idea of iterative plan revision. Both the framework and the fusion algorithm will be illustrated by an example from the field of transportation, where agents are transportation companies.

B.J. Grosz, S. Kraus, D.G. Sullivan and S. Das, The influence of social norms and social consciousness on intention reconciliation

Research on resource-bounded agents has established that rational agents need to be able to revise their commitments in light of new opportunities. In the context of collaborative activities, rational agents must be able to reconcile their intentions to do team-related actions with other, conflicting intentions. The SPIRE experimental system allows the process of intention reconciliation in team

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contexts to be simulated and studied. Initial work with SPIRE examined the impact of environmental factors and agent utility functions on individual and group outcomes in the context of one set of social norms governing collaboration. This paper extends those results by further studying the effect of environmental factors and the agents' level of social consciousness and by comparing the impact of two different types of social norms on agent behavior and outcomes. The results show that the choice of social norms influences the accuracy of the agents' responses to varying environmental factors, as well as the effectiveness of social consciousness and other aspects of agents' utility functions. In experiments using heterogeneous groups of agents, both sets of norms were susceptible to the free-rider effect. However, the gains of the less responsible agents were minimal, suggesting that agent designers would have little incentive to design agents that deviate from the standard level of responsibility to the group.

S. Sen, Believing others: Pros and cons

In open environments there is no central control over agent behaviors. On the contrary, agents in such systems can be assumed to be primarily driven by self interests. Under the assumption that agents remain in the system for significant time periods, or that the agent composition changes only slowly, we have previously presented a prescriptive strategy for promoting and sustaining cooperation among self-interested agents. The adaptive, probabilistic policy we have prescribed promotes reciprocative cooperation that improves both individual and group performance in the long run. In the short run, however, selfish agents could still exploit reciprocative agents. In this paper, we evaluate the hypothesis that the exploitative tendencies of selfish agents can be effectively curbed if reciprocative agents share their "opinions" of other agents. Since the true nature of agents is not known a priori and is learned from experience, believing others can also pose its own hazards. We provide a learned trust-based evaluation function that is shown to resist both individual and concerted deception on the part of selfish agents in a package delivery domain.

P. Faratin, C. Sierra and N.R. Jennings, Using similarity criteria to make issue trade-offs in automated negotiations

Automated negotiation is a key form of interaction in systems that are composed of multiple autonomous agents. The aim of such interactions is to reach agreements through an iterative process of making offers. The content of such proposals are, however, a function of the strategy of the agents. Here we present a strategy called the *trade-off* strategy where multiple negotiation decision variables are traded-off against one another (e.g., paying a higher price in order to obtain an earlier delivery date or waiting longer in order to obtain a higher quality service). Such a strategy is commonly known to increase the social welfare of agents. Yet, to date, most computational work in this area has ignored the issue of trade-offs, instead aiming to increase social welfare through mechanism design. The aim of this paper is to develop a heuristic computational model of the trade-off strategy and show that it can lead to an increased social welfare of the system. A novel linear algorithm is presented that enables software agents to make trade-offs for multi-dimensional goods for the problem of distributed resource allocation. Our algorithm is motivated by a number of real-world negotiation applications that we have developed and can operate in the presence of varying degrees of uncertainty. Moreover, we show that on average the total time used by the algorithm is linearly proportional to the number of negotiation issues under consideration. This formal analysis is complemented by an empirical evaluation that highlights the operational effectiveness of the algorithm in a range of negotiation scenarios. The algorithm itself operates by using the notion of fuzzy similarity to approximate the

preference structure of the other negotiator and then uses a hill-climbing technique to explore the space of possible trade-offs for the one that is most likely to be acceptable.

S. Matsubara and M. Yokoo, Defection-free exchange mechanisms based on an entry fee imposition

We propose a safe exchange mechanism involving indivisible goods and divisible goods. A typical situation is an exchange involving goods and money in a person-to-person trade in an Internet auction. Although the Internet and agent technologies have facilitated world-wide trade, we sometimes encounter risky situations, such as fraud, in the process of exchanges involving goods and money. This problem is becoming more serious with the growing popularity of person-to-person trade. One of the reasons why fraud is becoming widespread is that obtaining a new identifier in a network is cheap. This makes it almost impossible to exclude malicious agents from trade. One solution is to impose an entry fee. However, if the entry fee is too high, it will discourage newcomers from starting deals. To resolve the conflict between safety and convenience, we developed three exchange mechanisms that can guarantee against defection from a contract. Two of them reduce the entry fee by integrating multiple deals and controlling the flow of goods and money. The other reduces the entry fee by incorporating a third-party agent into the exchange process. We examine the lower bound of the entry fee for both of these mechanisms and describe a calculation method by which this value can be obtained in linear time. Our results show that the described mechanism can effectively reduce the lower bound of the entry fee.

T. Sandholm and Y. Zhou, Surplus equivalence of leveled commitment contracts

In automated negotiation systems consisting of self-interested agents, contracts have traditionally been binding. *Leveled commitment contracts*—i.e., contracts where each party can decommit by paying a predetermined penalty—were recently shown to improve expected social welfare even if agents decommit strategically in Nash equilibrium. Such contracts differ based on whether agents have to declare their decommitting decisions sequentially or simultaneously, and whether or not agents have to pay the penalties if both decommit. For a given contract, these mechanisms lead to different decommitting thresholds, probabilities, and expected social welfare. However, this paper shows that each of these mechanisms leads to the same social welfare when the contract price and penalties are optimized for each mechanism separately. Our derivations allow agents to construct optimal leveled commitment contracts. We show that such integrative bargaining does not hinder distributive bargaining: the surplus can be divided arbitrarily (as long as each agent benefits), e.g., equally, without compromising optimality. Nonuniqueness questions are answered. We also show that surplus equivalence ceases to hold if agents are not risk neutral.